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Supplementary Information

Photon assisted conducting atomic force microscopy study of nanostructured additives in P3HT:PCBM

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Band Gap Calculation:

Fundamental band gap determination can be done via UV-Vis Spectroscopy, in which electron excitation from the valance band to conduction band occurs upon absorption of the photons. The optical band gap can be determined by using following equation SE1, which is also known as Tauc equation[1].

$$\alpha = \frac{A(h\nu - Eg)^n}{h\nu} \qquad \textbf{(SE1)}$$

Where,

'α' is absorption coefficient of the material.

'*h*' is Planck constant.

'*Eg*' is the optical band gap energy of material.

'A' is a parameter depends on transition probability.

'*n*' is depends on type of transition. The values of '*n*' for direct allowed, indirect allowed, direct forbidden and indirect forbidden transition are 1/2, 2, 3/2 and 3, respectively.

Optical band gap of the material can be tuned with the help of additives. In this work, we have tried to absorbed more number of photon by the photoactive material (P3HT:PCBM) with additive like Ag NPs and Gr. It is observed that, with additives the band gap of the P3HT:PCBM has been reduce from 2.41 eV to 2.38 eV by adding Ag NPs. Similarly, for Gr as an additive it is found to be 2.23eV.

Scanning Electron Microscopy Analysis:

To ensure that the thickness of the films remained constant after the addition of the additives in the polymer blend, cross section FE SEM obtained for all three films. Figure SF1 shows the cross section view of P3HT:PCBM, P3HT:PCBM_Ag NPs and P3HT:PCBM_Gr thin films. Thickness of all the films have been observed from images (a), (b) and (c); which is approximately 100nm in each case.

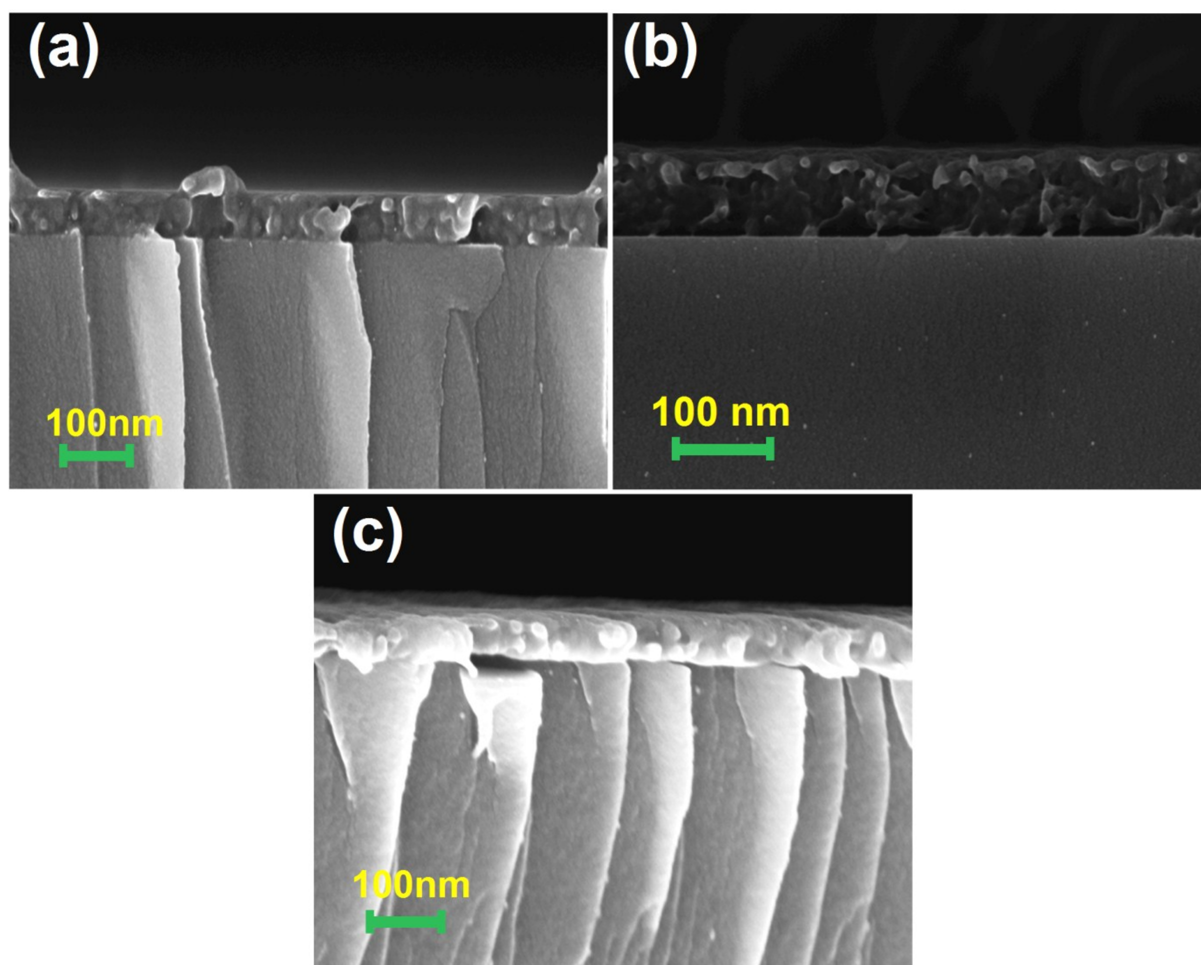

Figure SF1: Cross section view of (a) P3HT:PCBM, (b) P3HT:PCBM_Ag NPs and (c) P3HT:PCBM_Gr thin films, through FESEM measurements.

Atomic Force Microscopy Analysis:

P3HT:PCBM blend morphology does not depend on the applied bias and light exposure (different wavelength) which are shown in figure SF2 and SF3. Applied bias was varied from 0.0 V to 1.5 V in the C-AFM (Figure SF2). One can observe that there are no morphological changes with the applied bias voltage and exposure of light.

Our main intention is to improve the current with respect to exposure of different lights/wavelengths on the photoactive film. Figure SF3 (a), (b) and (c) shows the morphology of the blend under the exposure of violet (330-380 nm), blue (420-480 nm) and green (480-550 nm) lights. From the figure SF3, one can conclude that, the morphology of the blend remains same irrespective of light exposure.

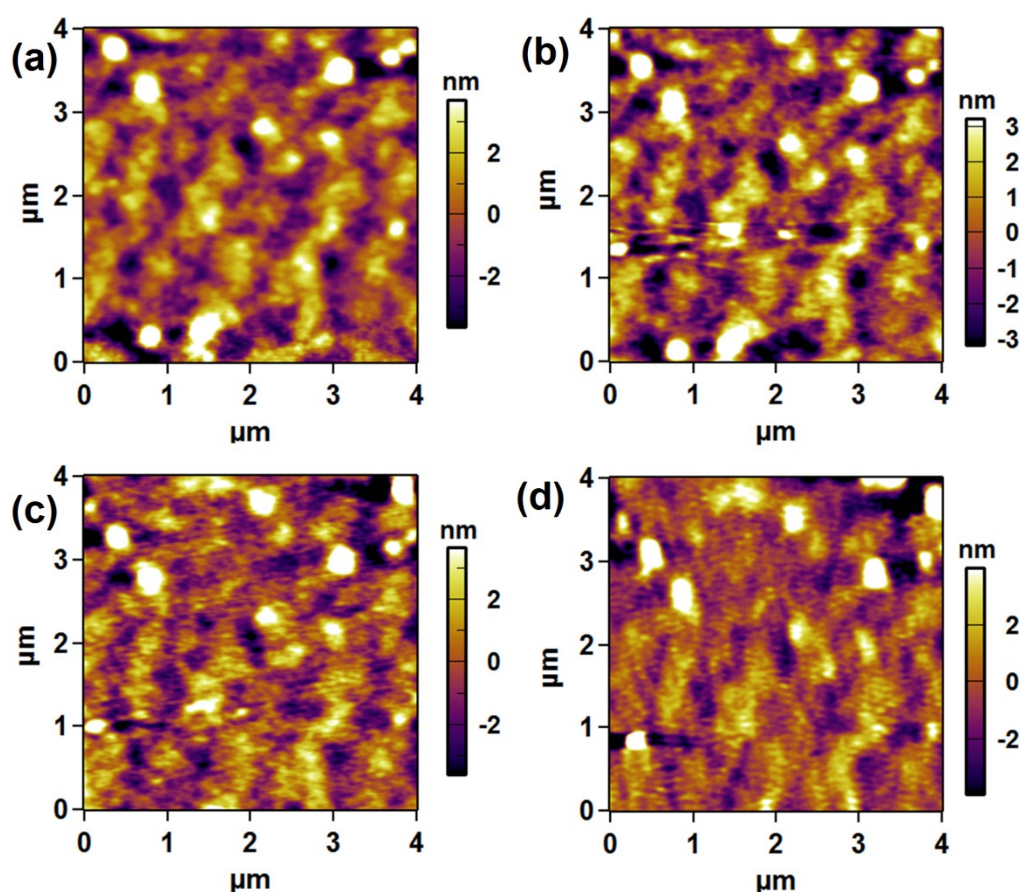

Figure SF2: AFM images of P3HT:PCBM shows morphological view under different applied bias (a) 0.0V (b) 0.5V (c) 1.0 V (d) 1.5 V.

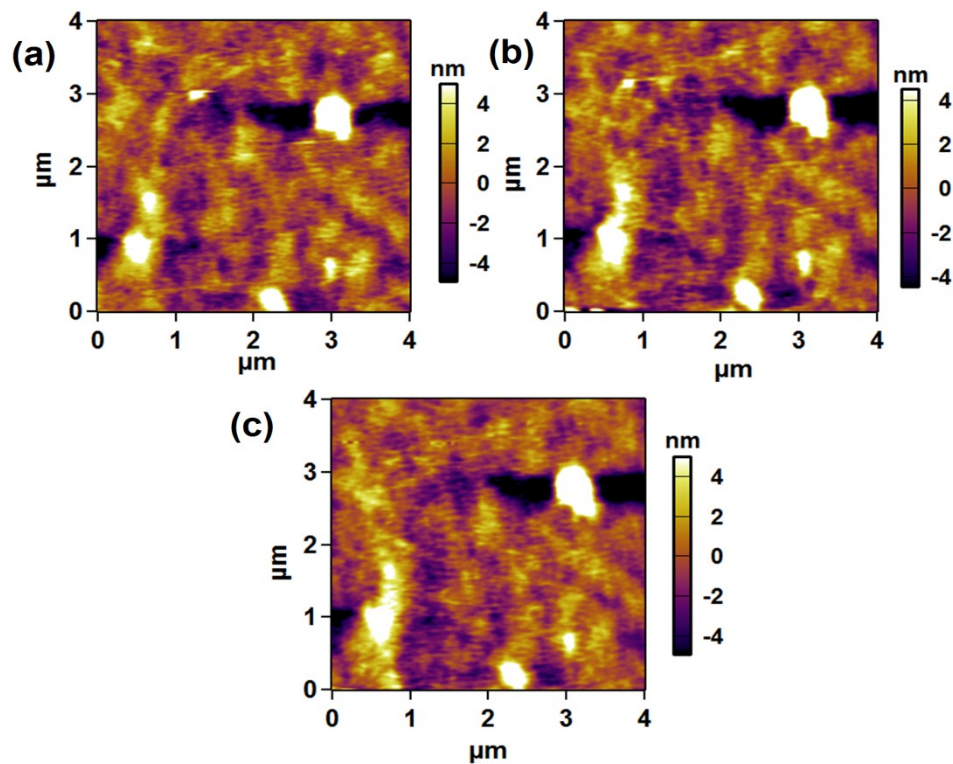

Figure SF3: AFM images of P3HT:PCBM shows morphological view under different exposure of lights/wavelengths bias (a) Violet (330-380 nm), (b) Blue (420-480 nm) and (c) Green (480-550 nm).

Reliability of carrier mobility calculation

Many researchers have reported mobility of P3HT:PCBM which has been calculated from field effect transistor (FET) measurements [2,3]. This reported value matches with our C-AFM measured value of carrier mobility. We were unable to get references for conventionally measured carrier mobility values for P3HT:PCBM_ Ag and P3HT:PCBM_ Gr. Since the carrier mobility values for P3HT:PCBM film measured by field effect transistor (FET) measurements and C-AFM measurements, we can say that the C-AFM measurements are reliable.

Reference

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